ORIGINAL

Unilateral rotation in baseball fielder causes low back pain contralateral to the hitting side

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Abstract : Low back pain (LBP) often occurs in baseball players ; however, the characteristics of the location of their LBP with respect to their throwing and hitting sides have not been clarified. In order to clarify the left-right asymmetry of LBP that occurs in baseball players, we surveyed 247 university baseball players using an LBP questionnaire. The main investigational items were : throwing and hitting side, position at the time of LBP experience, and LBP location. Based upon the indication of their throwing and hitting side, subjects were classified into unilateral rotational (UR) or bilateral rotational (BR) types. Subjects were also classified into categories of LBP location as described by ipsilateral or contralateral to dominant side of throwing or hitting. Chi-square test or Fisher exact test were used to compare LBP location side by rotational type (UR/BR) in all subjects and by position (pitcher/fielder). We found that among fielders, LBP occurring contralateral to the hitting side in UR was significantly more frequent than that in BR. We conclude that LBP occurred in baseball fielders with a left-right asymmetry, which suggests that high frequency unilateral rotation causes the lumbar region contralateral to the dominant hitting side to be subject to a high load. J. Med. Invest. 65 : 56-59, February, 2018

Keywords **:** *low back pain, university baseball player, left-right asymmetry*

INTRODUCTION

Baseball players have a high odds ratio of low back pain (LBP) occurrence, disk degeneration and spondylolysis compared to other athletes and nonathletes (1-4). The reason behind the high odds ratio is the playing characteristics of baseball in throwing and hitting, which require a capability to transfer force from the lower limb to the upper limb. During the transfer, the lumbar region is reportedly subjected to high loads (5-7).

Baseball players have asymmetric physical characteristics since each player has their own dominant side of throwing and hitting. The thickness of the trapezius, the muscle power of shoulder internal rotation, the range of motion at the shoulder and hip, and abdominal oblique muscle strain are indicative of the asymmetry (8-12). We assumed that there would be a left-right asymmetry with regard to LBP occurrence in baseball players due to the asymmetric physical characteristics. Baseball players can be categorized into two rotational types based on throwing and hitting side : unilateral rotation type (UR : throwing right and hitting right, throwing left and hitting left) and bilateral rotation type (BR : exceptions to the above). Considering that UR rotates in the same direction in both throwing and hitting while BR rotates in different directions, we hypothesized that LBP location differed between UR and BR.

Previous studies about LBP in baseball players have indicated that fielders have a high odds ratio of LBP occurrence compared to pitchers (13) and that this is related to self-training and time spent hitting (14). However, there are still many unclear points for prevention and improvement of LBP in baseball players. Therefore, it is necessary to gather detailed information, such as LBP location and baseball motions inducing LBP, and to clarify the characteristics of LBP in baseball players. Clarification of the characteristics of LBP in baseball players' throwing and hitting sides, as attempted in this study yields important data to elucidate the mechanism of LBP in baseball.

This study aimed to investigate LBP occurrence rate and a left-right asymmetry with regard to LBP occurrence in baseball players while focusing their own throwing and hitting side.

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PATIENTS AND METHODS

Subjects

We emailed 497 university baseball players by attaching an explanatory documents to research participants with a link to a Google form (https : //goo.gl/4TR5NJ) containing an LBP questionnaire. A total of 247 players completed the questionnaires with an average age of 21±2 years and an average of 13±2 years of baseball experience. This study was approved by the relevant institutional ethics committee of Waseda University (approval number, 2016-285). The subjects' approval was confirmed by their answering the LBP questionnaire.

Answering questionnaire

We made the LBP questionnaire on the internet using Google form (Google Co. Ltd). In this method, subjects can access the website and answer the LBP questionnaire on the web without a paper questionnaire. Subjects firstly read "Explanatory documents to research participants" which was attached to the email message, then accessed the website and answered the LBP questionnaire on the internet.

Investigational items and analysis

The LBP questionnaire gathered the following pieces of basic information : age, baseball experience, one major position at each age (elementary school, junior high school, high school, university) and throwing and hitting side, as well as LBP information : LBP experience number (once or multiple or no), LBP age, LBP location (Figure 1), baseball motion-induced LBP (throwing,

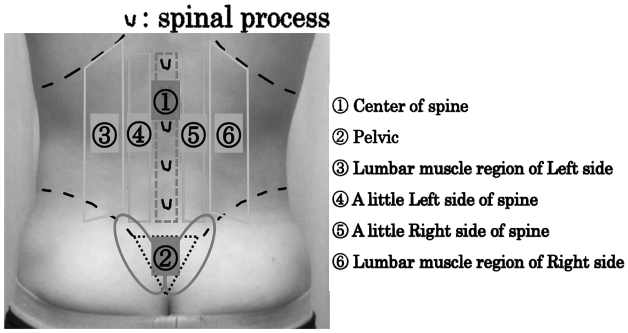

Figure 1 : LBP location

hitting, running, catching a grounder, sliding). Subjects who indicated they have had multiple experiences of LBP answered LBP information for their first three experiences of LBP. From the LBP questionnaire results, we calculated the LBP prevalence rate for all subjects, by position (pitcher / fielder), and by throwing and hitting side (UR : Unilateral Rotation / BR : Bilateral Rotation). We also gathered the cumulative total numbers of baseball motions inducing LBP and LBP location with respect to throwing and hitting side (Table 1). Concerning LBP experience, the presence of LBP was determined by an answer of "once" or "multiple". Whereas the absence of LBP was determined by an answer of "no".

As for LBP prevalence rate by position (pitcher or fielder), we counted the total number by position (pitchers or fielders) at each age (※cumulative total number), and the incidence of LBP by position at each age. Then, incidence of LBP by position at each age was divided by the totals number by position at each age, and LBP prevalence rate by position was calculated.

To demonstrate the difference of LBP prevalence rate by position, position and LBP were analyzed to compare LBP prevalence rate between pitchers and fielders. Likewise, to demonstrate the difference of LBP prevalence rate by throwing and hitting side (UR or BR), throwing and hitting side and LBP were analyzed to compare LBP prevalence rate between UR and BR.

The correspondence between LBP location and throwing and hitting side was analyzed as follows. Subjects selected their LBP location (multiple answers were permitted) from six regions in Figure 1. The six regions were categorized as follows : center LBP (regions 1 and 2), left LBP (regions 3 and 4), and right LBP (regions 5 and 6)". After all the collections, we made 4 groups regarding the LBP locations : "center LBP", "one-sided LBP", "both-sided LBP" and "unknown". If subjects only selected either left LBP or right LBP, they were grouped as "one-sided LBP". Furthermore, subjects who selected both left LBP and right LBP were grouped as "both LBP" while subjects who selected "not remember" were grouped as "unknown". Among the 4 groups, our analysis focused on "one-sided LBP" for a reason of our interest to the LBP location asymmetry.

The answers of "one-sided LBP" were categorized into "ipsilateral or contralateral LPB regarding dominant side of throwing" and "ipsilateral or contralateral LBP regarding dominant side of hitting". Subsequently, the categorized LBP location side (ipsilateral or contralateral to dominant side of throwing or hitting) were divided into UR and BR. This detailed categorization was reflected on all players, pitchers and fielders, respectively. In addition, switch hitters were excluded from the analysis of dominant side of hitting due to the difficulty of identification of their dominant hitting side (either ipsilateral or contralateral).

For statistical analysis, Chi-square test or Fisher exact test were used to compare LBP prevalence rate by pitcher / fielder and by UR / BR, and to compare LBP location side by UR / BR in all players, pitchers and fielders. The significance level was set at an alpha of less than .05. All statistical analyses were performed using SPSS 24.0 for Windows (IBM, SPSS Statistics 24.0, Japan).

RESULTS

The LBP prevalence rate in all players was 68.4% : 169 out of 247 players. Frequency of LBP occurrence was found to be as follows : once 25.5% (63 players), twice 38.0%(94) and three times 4.9%(12). Comparing by position, the occurrence of LBP in fielders was significantly higher than in pitchers ($p < 0.05$, 34.5% vs. 18.5%). On the other hand, comparing by throwing and hitting side, UR (Unilateral Rotation) and BR (Bilateral Rotation) ($p = 0.129$, 64.9% vs. 74.2%) were not significantly different.

The baseball motions reported to induce LBP were hitting (171 cases, 29.4%), running (141 cases, 24.2%), throwing (140 cases, 24.1%), catching a grounder (87 cases, 14.9%), and sliding (43 cases, 7.4%).

With regard to the difference in LBP location by UR and BR, there was no significant difference in the comparison of all players (both dominant throwing and hitting side) and pitchers ($p=0.290$, 0.067, 0.240). In contrast, there was significant difference in fielders. LBP occurring contralateral to the dominant side of hitting in UR fielders (e.g. throwing right and hitting right player with left-sided lumbar pain) was significantly more frequent than that in BR fielders (e.g. throwing right and hitting left player with right-sided lumbar pain) (Table 2, $p < 0.05$, 65.1% vs. 41.5%).

Table 1. The number of LBP location by dominant throwing and hitting side

		LBP location						
		Center	Left	Right	Both	Unknown	Total Number of LBP	Total Number of Player
Dominant	RR	30	47	32	23	15	147	130
Throw	RL	32	23	22	6	12	95	80
&	RB	8	5	2	1	0	16	11
Hitting	LR	0	0	1	0	0	1	2
Side	LL	10	1	14	2	1	28	24
	Total	80	76	71	32	28	287	247

Abbreviations : RR, throwing right and hitting right ;
RL, throwing right and hitting left ; RB, throwing right and hitting both sides ;
LR, throwing left and hitting right ; LL, throwing left and hitting left

Table 2. Comparison of LBP location by UR / BR in all players, pitchers and fielders

		LBP location	
	All Players	Ipsilateral to dominant side of throwing	Contralateral to dominant side of throwing
Dominant Throw & Hitting Side	Unilateral Rotation	33	61
	Bilateral Rotation	24	29
	N.S. (p = .290)		

		LBP location	
	All Players	Ipsilateral to dominant side of hitting	Contralateral to dominant side of hitting
Dominant Throw & Hitting Side	Unilateral Rotation	33	61
	Bilateral Rotation	24	22
	N.S. (p = .067)		

		LBP location	
	Pitchers	Ipsilateral to dominant side of throwing	Contralateral to dominant side of throwing
Dominant Throw & Hitting Side	Unilateral Rotation	11	10
	Bilateral Rotation	8	3
	N.S. (p = .450)		

		LBP location	
	Fielders	Ipsilateral to dominant side of hitting	Contralateral to dominant side of hitting
Dominant Throw & Hitting Side	Unilateral Rotation	30	56
	Bilateral Rotation	24	17
	p=.013	OR (95% CI) : 2.6(1.2-5.7)	

Abbreviations : N.S., not significant ; OR, odds ratio ; CI, confidence interval

DISCUSSION

Previous studies reported that baseball players have a high odds ratio of LBP occurrence (1-4). The LBP prevalence rate amongst 68% of the university baseball players we surveyed is consistent with these studies. Concerning detailed information of LBP in baseball players, Tajima *et al.* (13) clarified that fielders have a high odds ratio of LBP occurrence compared to pitchers. In another study, Tasaka *et al.* (14) reported that this is related to self-training and time spent hitting and LBP occurrence. In our study, LBP prevalence rate in fielders (34.5%) was significantly higher than in pitchers (18.5%). These results suggest that LBP occurrence in baseball players is strongly correlated with hitting, which tends to be performed by fielders. With respect to the lumbar region load in hitting, Sairyo *et al.* (15) reported that high load was exerted upon the zygapophyseal joint of the vertebral arch by rotational motion of the lumbar region. In addition, Shaffer *et al.* (16) indicated the presence of high erector spinae electromyographic activity (85~185%MVC) during hitting. Therefore, it is suggested that hitting causes the lumbar region to suffer a high load.

Accordingly, comparing LBP location by unilateral and bilateral rotation (UR and BR) in fielders who mainly hit, LBP occurring contralateral to hitting side in UR fielders was significantly more frequent than that in BR fielders. This result may suggest the different load to lumbar region by the difference rotational orientation. Whereas BR fielders are not required to rotate in same direction in both throwing and hitting, UR fielders are required to repeatedly rotate in same directions which causes high frequent load to contralateral lumbar region to hitting side. Baseball hitting is motion that transfer rotational force from the lower limb to the upper limb and bat through the trunk (17). With respect to lumbar, the lower lumbar is assumed to rotate before the upper lumbar. The rotation of the lower lumbar preceding the upper lumbar means the relative contralateral rotation of the upper lumbar. From the finding that high stress occurs at the pars interarticularis on the contralateral to the rotational direction of the upper lumbar (15), mechanical stress to the pars interarticularis on contralateral to the hitting side is considered to be high in the phase that the lower lumbar rotates toward the pitcher after the start of swing. (Figure 2, e.g. As for the hitting right, left L4 / 5 facet joint is compressed, and mechanical stress on left L4 pars interarticularis increases when L5 rotates to the left before L4.) In connection with the suggestion of left-right asymmetry in baseball players as above, there are many studies concerning the left-right asymmetry of physical characteristics in baseball players. Specifically, Conte *et al.* (12) indicated that abdominal strain in Major League baseball players often occurred contralateral to the hitting side, although the abdomen is different from the low back. From previous and current studies, it is suggested that high load is exerted on the left side of the trunk (abdominal oblique muscle, erector spinae muscle, and the zygapophysial joint) in the case of a player that throwing right and hitting right. However, this study did not investigate LBP pathophysiology. Since the LBP occurrence is

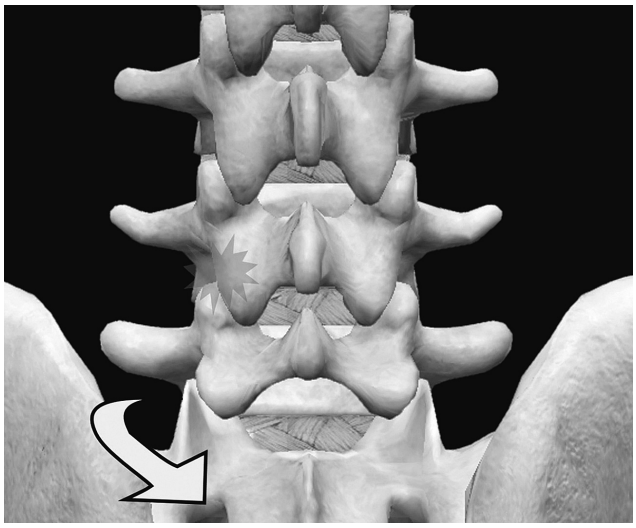

Figure 2 : Stress mechanism on left pars interarticularis about hitting right

decided by its pathophysiology, further investigation of LBP including biomechanical studies are needed to clarify a left-right asymmetry in LBP.

In conclusion, the LBP prevalence rate in university baseball players was 68.4%, and that of fielders (34.5%) was higher than that of pitchers (18.5%). Comparing LBP location between unilateral rotation (UR) and bilateral rotation (BR) in fielders, LBP occurred contralateral to the hitting side in UR (e.g. throwing right and hitting right player had pain in the left lumbar region) was significantly more frequent than that in BR.

CONFLICT OF INTERESTS-DISCLOSURE

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